Ross Fig. 4, Ross uses two TV cameras, a first TV camera 52 having a red filter for imaging only the red spectrum of the scenery, and a second TV camera 54 having a green filter for imaging only the green spectrum of the scenery. The third TV camera which in the conventional case images the third basic color, i.e., blue, is missing from Ross device, and is replaced by IR TV camera 50. Accordingly Ross et al.'s device is (a) not identical to the claimed invention, (b) unable to generate the claimed visible spectrum (a.k.a., true color) image, and (c) unable to perform the desired task of identifying electrical discharges and illustrating those charges on a composite visible spectrum (a.k.a., true color) image as claimed. Moreover, none of the other cited references assist Ross et al. in teaching, suggesting, or motivating any of these missing elements. For a more detailed analysis of this opinion, please read below.

ROSS ET AL.'S DEVICE IS GENERATES ONLY FALSE COLOR IMAGES

The examiner mistakenly asserted Ross et al. device can generate a visible spectrum (a.k.a., true color) image. In particular the examiner wrote, in the section entitled Response to Arguments, ". . . Ross et al. also disclose (column 5, lines 63-68) combining and (displaying) the true-color visible view with a visible image of the non-visible radiation." That statement must be a mistake because Ross et al. clearly and unambiguously disclose the image is a false-color image. We have this opinion because Ross et al. disclose at the paragraph starting at column 5 line 63 that its device generates a false-color image. To confirm this opinion we have cited the entire paragraph that starts at column 5 line 63:

> In order to provide a second "visible image" of object 12 for combination with the IR image, the beam splitter 102, reflector 104, suitable optics 106, reflector 108, and half-silvered mirror 110 are suitably positioned to project an image of object 12 through eyepiece 100 in registry with the IR image. The resultant light rays passing through eyepiece 100 combine to **produce a composite false colored image** similar to that produced in the previously described embodiments. As in the previous embodiments, **the composite false colored image** viewed by the observer at 98 will indicate those portions of object 12 having different IR reflectivity characteristics than other portions. Apparatus such as this are highly useful to foresters, nurserymen and others concerned with making on-the-spot evaluations of plant growth or disease conditions.

(Bold added for emphasis.)

That paragraph clearly and unequivocally contradicts the examiner's opinion because Ross et al. disclose its device generates a **COMPOSITE FALSE COLORED IMAGE**. Ross et al. must realize that the reflector 104, the suitable optics 106, the reflector 108, and/or the half-silvered mirror 110 must filter at least one color from the visible spectrum to generate the composite false colored image. As said, this is also clearly shown in Fig. 4, where the blue signal from the scene is eliminated (only red 52 and green 54 signals are used), for the purpose of showing the IR TV camera signal 50.

That paragraph, along with the entire specification, confirms Ross et al.'s title for U.S. patent number 3,748,471 is accurate. That title is a **FALSE COLOR** RADIANT ENERGY DETECTION METHOD AND APPARATUS.

WHAT IS THE DIFFERENCE BETWEEN FALSE COLOR AND TRUE COLOR?

True-Color

A true color image is one in which the captured scenery is displayed in its original real colors. As defined by Wikipedia (The free encyclopedia - http://en.wikipedia.org/wiki/False_color): "A true-color image of a subject is an image that appears to the human eye just like as the original subject would: a green tree appears green in the image, a red apple red, a blue sky blue, etc. When applied to black-and-white images, *true-color* means that the perceived lightness of a subject is preserved in its depiction." That definition conforms to another "true color" definition found at http://whatis.techtarget.com/definition/0,,sid9_gci213224,00.html. At the Whatis.techtarget.com website, it was written, "True color is the specification of the color of a pixel on a display screen using a 24-bit value, which allows the possibility of up to 16,777,216 possible colors."

True color images can be obtained through conventional imaging devices that do not have filters that eliminate a color from the visible spectrum. The visible spectrum (a.k.a., true color) imaging units described in this application are conventional visible imaging devices. That statement can be confirmed by reviewing page 35 wherein the applicants wrote, "the components by which the invention can be carried out are conventional" and identified at pages 36 and 39, respectively, that the visible imaging units can be a Hitachi visible CCD camera or a Panasonic NV-MC20E CCD color video camera.

Antecedent Basis for True Color Language

There are at least three reasons there is antecedent basis for true color as used in the claims, for example, the current visible spectrum (a.k.a., true color) imaging units generate a visible spectrum (a.k.a., true color) image. Those three reasons are as follows:

1. The visible spectrum imaging units are conventional commercial products without filters that generate visible spectrum images, a.k.a., true color images.

2. No where in the specification is there any reference to the visible spectrum imaging units having a filter (which Ross et al. requires) to delete or eliminate a color from its generated visible spectrum image, a.k.a., a true color image.

3. At page 12, lines 8 to 10, the present application explicitly discloses, [the] "visible imaging unit receiving an image of the field of view from the image acquiring means, and displaying a **visible spectrum image of the field of view**."

> The term "visible spectrum", as defined at *Merriam-Webster's Medical Dictionary*. Merriam-Webster, Inc. at <Dictionary.com http://dictionary.reference.com/browse/visible spectrum>, means "the part of the electromagnetic spectrum to which the human eye is sensitive extending from a wavelength of about 400 nm for violet light to about 700 nm for red light."

That means, in lay man's terms and to those of ordinary skill in the art, the visible spectrum imaging unit generates images that do not exclude, by filters, any color – red, orange, yellow, green, blue, indigo, violet – from the visible spectrum, a.k.a., true color images. This is in contrast to Ross, which clearly uses two, red and green filters (52 and 54 respectively), while excluding the blue color which is typically used, wherein said blue color filter is replaced by the an IR filter 50 (see Ross Fig. 4).

In view of these three reasons and many more, it is evident the invention's visible spectrum (a.k.a., true color) imaging units must generate visible spectrum (a.k.a., true color) images. And the invention's system of (a) visible spectrum (a.k.a., true color) imaging units and (b) SBUV imaging unit generate (c) a composite image of the visible spectrum (a.k.a., true color) image and the SBUV emittance image to illustrate the UV emittance on a visible spectrum (a.k.a., true color) image. Accordingly, there is implicit antecedent basis for the term "true color" in the

claims, and that term appears to be necessary since the examiner believes Ross et al.'s false color images are identical to the claimed invention, which it is not.

False Color

In a false color image, however, one or more of the red, green and blue signals is replaced by the signal from a sensor responding to some other wavelength band, be it short wave infrared, thermal infrared etc, and usually a filter is provided to color the output of the invisible channel. The result is that objects are shown in colors which are not their natural colors and which depend on the relative signal intensity levels in the different inputs. For example, if the red channel input comes from a near-infrared sensor and if a filter will tint the infrared sensor output in red color, then healthy foliage, which reflects more strongly in near infrared, will appear bright red while dark rocks will appear to be blue-green as the input to the red channel is low.

In Wikipedia, "The term "false color" is typically used to describe images whose colors represent measured intensities outside the visible portion of the electromagnetic spectrum." In the combined image, the "visible" channel of Ross et al. displays the "visible" image using two colors, for example, blue and green, and the "invisible" channel of Ross et al. is a tinted mono-color channel (red in the example of the foliage image – Fig. 2 of Ross et al.), which outputs various levels of signal, relating to the "invisible" radiation emanated from the object in the view. In the apparatus of Ross et al. the scenery is displayed in false color in order to highlight differences in the objects viewed, for example the difference between sick and healthy foliage.

WHY ROSS ET AL.'S DEVICE CAN ONLY GENERATE FALSE-COLOR IMAGES

Ross et al.'s device is, at best, a conventional imaging device having FILTERS to generate a false color image. To confirm that statement, we direct your attention to the title and the sentence at column 6, lines 11 to 17, which are as follow:

> **FALSE COLOR** RADIANT ENERGY DETECTION METHOD AND APPARATUS
>
> The present invention may be implemented using any suitable real-time image generating apparatus capable of developing **several** spectrally different images of the same object which can be either electrically or optically combined

> into a single composite image that accentuates certain characteristics of the object which would otherwise be undetectable by the naked eye.

Ross et al. teach away from using conventional visible imaging devices that generate visible spectrum (a.k.a., true-color) images. Every image identified by Ross et al. is a false color image. In particular, Ross et al. explicitly teach its imaging devices must generate SEVERAL spectrally different images of the same object.

The term "several," according to *The American Heritage® Dictionary of the English Language, Fourth Edition*. Houghton Mifflin Company, <Dictionary.com http://dictionary.reference.com/browse/several>, means "being of a number more than two or three but not many." That definition conforms to Ross et al.'s disclosure of his invention that can be found in the title (set forth above), the sentence at column 6, lines 11 to 17 (see above), and at column 5, lines 1 to 20, which reads as follows:

> Through the use of filters 70, 72 and 74 in the input optics of the respective cameras, the radiation to which each camera responds is selectively limited to particular portions of the spectrum. For example,
>
> > filter 70 permits only radiation in the near IR portion of the spectrum to enter camera 50,
> > filter 72 permits only radiation in the red portion of the spectrum to enter camera 52, and
> > filter 74 permits only radiation in the green portion of the spectrum to enter camera 54.
>
> The video tubes used in the respective cameras 50, 52 and 54 must therefore be selected to have good sensitivity to the particular input radiation. Whereas the well known Plumicon or Vidicon tubes may be used in cameras 52 and 54, a Tivicon image tube, or its equivalent having good near IR response should be used in camera 50. For system uniformity, the cameras 50, 52 and 54 may be of a single type, such as the Standard IV Model manufactured by the Sierra Scientific Corporation of Mountain View, Calif., since such camera is adapted for use with many of the standard video camera tubes.

(Placed in outline format for emphasis.)

Ross et al. teach each imaging device MUST have a filter on an image generating device to generate the desired false color images. No where do Ross et al. disclose that the desired generated image is a visible spectrum (a.k.a., true color) image. Every instance, Ross et al.

disclose the generated image is a FALSE COLOR IMAGE. Moreover, Ross et al. NEVER suggest, teach or motivate any one to generate a true-color image to illustrate infrared areas.

The Applicants' invention displays the visible spectrum view in true color through at least a conventional visible imaging device and when combined with the image from the SBUV imaging device the resulting image is a composite true color image that illustrates SBUV emittance. Therefore, by Ross teaching a false color device and explicitly teaching away from using an imaging device that generates visible spectrum (a.k.a., true color) images, they teach away from the current claimed invention. This is in addition to Ross et al.'s teaching of the determination between levels of invisible reflections (from foliage or oil), while the present invention teaches detection and location of electrical discharge, which is associated with SBUV emittance.

Additional Novelty and Inventiveness

Independent claims 1 and 35 (method claims) and claim 8 (apparatus claim) respectively relate to the detection and location of **electrical discharges** over electrical equipment in full daylight or equivalent artificial indoor illumination while using a conventional visible spectrum (a.k.a., true color) imaging device.

Electrical discharges generally occur on high voltage (HV) lines and equipment due to failure of insulation or equipment components leading to a high local electric field. The term "Electrical discharge" generally relates in the art to the phenomena of partial discharge, corona (the examiner's interpretation for electrical discharge does not include corona; that interpretation violates the this application's teachings that an electrical discharge includes corona; however, to obtain an expedited prosecution of this application the applicant has elected to delete in claims 60 to 62 that the electrical discharge can be selected from a group that includes corona. By no means has the applicant altered its explicit teaching that electrical discharge includes corona.), and arcing. All said three types of electrical discharge are associated with very weak UV emission, which cannot be observed in daylight or even in indoor artificial illumination.

There are various known negative effects of electrical discharges in general, just to mention a few: (a) audible noise; (b) radio and TV interference; (c) generation of toxic and corrosive materials as ozone and nitrogen oxides that produce nitric acid at high humidity; (d)

damage to the electrical equipment on which the corona appears due to the generated corrosive material; (e) ignition danger to other close objects; and (f) various biological effects and negative health effects, as recently discussed in many papers.

Therefore, when electrical discharge appears on electrical equipment there is often a high necessity to locate and fix the failure. The fact that the electrical discharge is associated with an audible, noise and the use of ultrasonic detectors, does not help much in finding the exact location where the discharge takes place. The only exhibited sign, which could direct the engineer to the existence of the failure, and to the location of the discharge is the UV emittance involved with the discharge. However, unfortunately the weak UV emission of HV electrical discharges cannot be detected and exactly located at high illumination, and particularly in daylight.

The problem is very acute particularly on HV transmission and distribution lines of electrical companies which obviously span many thousands of miles (and more), and which are very hardly accessible. The problem is also acute in transformation substations. According to the prior art maintenance crews had to work during nights in order to detect and locate the discharge problem, and they also had to repair the problem generally at dark conditions.

Working on the very high voltage poles is complicated and dangerous even during high illumination (day) conditions, but no doubt the complication becomes significantly higher during nights. The payment to the maintenance crews is also significantly higher for their work during the nights.

The only way by which an electric discharge can be detected during daytime is the observation of its UV emission in the solar blind band (240-280nm), where the sun radiation reaching the earth is practically zero due to the ozone absorption in this spectral band. The corona emission in the solar blind band is very weak in intensity and therefore it can be detected only by the use of an imager, which comprises a so called solar blind image intensifier coupled to a solar blind filter (or an image intensified SBUV image sensor). Such an imager almost totally blocks radiation out of the solar blind spectrum. However, even with such an imager (for example as disclosed by Dirscherl) that is sensitive enough to detect and display indications for single photons in the SBUV band, and with sun background noise as low as the dark noise, the electric discharge can be detected, but not exactly located, making such a device to be almost useless for fulfilling the objects as described above. This is in view of the fact that detection,

without exact location of the faulty electrical component, does not enable repair. Furthermore, a detection and location of the electric discharge in which the background equipment is shown in true color is highly desirable, as it enables much more efficient and convenient work. Such a device for detection and location of electric discharge in daylight, and in true color has never been proposed in the art prior the date of the invention. In fact, the inventors have found that using a SBUV image intensifier as described in independent claims 1, and 8, provides visual indication and location of the electrical discharge even in the level of single photons, and enables showing the background equipment in true color. Applicant comments that imagers based on the method of claim 1 and apparatus of claim 8 are presently in use by preventive maintenance crews in many utilities worldwide.

Claim 35 also provides detection and location of electric discharge in daylight by combining the solar blind image with an IR image of the electric equipment. Although a structure as in claim 35 does not show the background equipment in true color, it still enables detection and location of the electric discharge in daylight, and it also provides indication of hot regions due to current flow in the equipment, an indication which is also important for repairing the problem. Such a structure of a device for detecting and locating electric discharge has also never been proposed prior to the date of the invention.

Therefore, present claims 1, 8 and 35 provide a method and apparatus for the detection and location of electric discharges which are associated with UV emittance in full daylight. While in claims 1 and 8 the background display of the equipment is shown in its true color, in claim 35 still other advantages are obtained, such as the detection and location of hot regions in the equipment. The art has never suggested prior the date of the invention such a solution for the detection and location of electric discharge, although there was a very long felt need for many years for such a solution.

The Applicant believes that independent claims 1, 8, and 35 are inventive, also for the following reasons:

None of the publications cited by the Examiner suggests, or even hints to a device and method for detecting and locating UV emittance of electric discharge on electrical equipments in daylight, as in amended claims 1, 8, and 35, and on true-color images. As said, prior to the date of the invention there was a very long felt need for a solution to the problem of detecting and locating electrical discharge in electrical equipment, and only

the present invention has satisfied this long felt need. The Applicant comments that any invention involves two stages: (a) a first stage in which the inventor observes a problem; and (b) a second stage in which the inventor provides a solution to the problem. In this case, neither Dirscherl nor Ross even raised the problem (i.e., detection and location of electric discharge in electrical equipment in daylight) and the use of conventional visible imaging devices that generate true-color images that are combined with UV generated images to obtain a true-color image illustrating UV emittances, that the present invention solves. Dirscherl invention is targeted to the detection of emittance from combustion in flying objects, such as missiles (see abstract), and Ross invention is targeted to "determine the presence of polluting conditions, such as oil on water or certain gases in the atmosphere, or foilage disease or stage of growth. In addition, the detected conditions can be electrically recorded for subsequent re-evaluation or comparison" (col. 2, lines 18-22).

Ross, in **all** his embodiments and **all** his claims teaches a device which forms a <u>false</u> color combined image.

Applicant believes that one having ordinary skill in the art would not combine the knowledge of Dirscherl and Ross to form a device for detecting electric discharge in electrical equipment unless using hindsight (i.e. applying knowledge of the present invention). Ross and Dirscherl do not, even remotely address the problem that the present invention solves (i.e., detection and location of electric discharge), and there is no hint in neither of them that would motivate a skilled person to combine them. Moreover, even if someone would combine these two references, he would still not obtain the apparatus of the present invention, as the combined apparatus will be a false color apparatus. Applicant believes that Ross, by teaching a method and apparatus to combine "a composite of <u>false colored image</u> highlighting those portions of the object having a high degree of <u>reflectance</u> in the non-visible spectrum" (see abstract lines 5-8) clearly teaches away from the invention, which teaches detection and location of a phenomenon which involves <u>emittance even in the level of single photons</u>, and with <u>true color image of the background</u>.

Claim 35 suggests imaging in both the IR and SBUV spectral regions, and to combine them in a registered manner in order to enable detection and location of electrical discharge. In this manner, the background image is the IR image, and therefore

hot regions of the equipment can also be detected and located with reference to said UV emittance of electric discharge. This is still another method that none of the prior art suggests. The IR image of claim 35, though not a true color image, shows the details of the IR emittance from the electrical equipment, and thus the combination with the SBUV image enables the detection of both electrical discharges and hot regions of the equipment, that are indicative of internal defects in the electrical equipment.

Therefore, the Applicant believes that independent claims 1, 8, and 35 are both novel and inventive. The rest of the claims are novel and inventive in view of their dependency of inventive claims.

The Examiner has cited the publication of Baril against dependent claims 24, 25 and 26. The Applicant believes that said rejections of claims 24 and 25 and 26 are moot in view of the above arguments.

The Examiner has cited the publication of Willey (US 5,841,574) (when combined with Dirscherl and Ross) against dependent claims 59. The Applicant believes that said rejection of claim 59 is moot in view of the above arguments.

The Examiner has also cited Kotze (GB 2278435) and Applicant believes that reference fails to address the missing limitations of the claimed invention.

<u>35 USC 112 Issues that are Traversed by Applicant</u>

1a. The examiner believes the use of the acronyms "BCCD" and "EBCCD" in claim 18 "fail to further limit the subject matter of a previous claim" because those acronyms do "not appear to be an image intensified SBUV image sensor." The examiner's conclusion is based on the following extract found in the office action:

> The specification discloses (first paragraph on pg. 20) that "Ultraviolet image sensor 13 may be of any of the types including but not limited to charge coupled devices, back illuminated charge coupled devices, and photocathode based devices such as image intensifier tubes, intensified charge coupled devices, and electron bombarded charge couple devices."

We are confused by the examiner's conclusion because item 13 is also identified as an "ultraviolet image intensifier" at page 31. In other words, the applicant properly used the terms "ultraviolet image sensor 13" and "ultraviolet image intensifier 13" interchangeably. That means

what is described for one is good for the other, which means there is antecedent basis for BCCD and EBCCD as image intensified SBUV image sensors. As such, the examiner's objection appears erroneous. It is respectfully requested the examiner rescind this objection.

1b. Claim 18 was further rejected because the examiner asserts there does not appear to be a written description of the claim limitation "the image intensified SBUV image sensor is selected from among a group of sensors consisting of BCCD, EBCCD, ICCD, MCP-PMT having multianode, and MCP-PMT having position sensitive anode output." Applicant is confused by the examiner's rejection because the applicant properly used the terms "ultraviolet image sensor 13" and "ultraviolet image intensifier 13" interchangeably. It is respectfully requested the examiner rescind this rejection.

2. The examiner has rejected numerous claims under the opinion that the claim limitation "a solar blind filter, image intensified sensor, and a UV photocathode" is not supported in the specification because "there does not appear to be disclosure of an UV photocathode in addition to an image intensified sensor in the specification as filed." Applicant respectfully traverses that opinion because at page 31, the applicant wrote, "Ultraviolet objective lens 12 focuses radiation transmitted by solar blind ultraviolet optical filter 11 onto photocathode 13A of ultraviolet image intensifier 13, . . . photocathode 13a emits electrons in response to ultraviolet radiation impinging on it, creating an electron image . . . Said electron image is amplified in microchannel plate (MCP) 13b . . ." As such photocathode 13a is a first sub-part of an intensifier and the microchannel plate is a second sub-part of the intensifier that operates independently of the first sub-part. Accordingly, the rejected limitation does have sufficient antecedent basis and the examiner's rejection should be rescinded.

3. The examiner has rejected the claim limitation of "one combined and exactly registered true color visual image" because there is no written description of what is the visible color of UV. It is respectfully requested the examiner review the entire application. The claims clearly and unquestionable set forth the composite visual image showing in real time the location and nature of the SBUV emittance of the electrical discharge on the visible spectrum (*a.k.a.*, true color) representation of the scene. In other words, there is no color of UV, instead the SBUV emittance is located and illustrated on the color image of the scene to make it easier to identify and locate the equipment. For at least this reason, it is respectfully requested the examiner rescind this rejection.

The remaining rejections and objections have been addressed by numerous amendments in the specification. It is believed the numerous amendments properly address the examiner's concerns and therefore the examiner's objections and rejections should be rescinded. It should be noted that every amendment has clear and unambiguous antecedent basis throughout the specification.

Conclusion

It is respectfully submitted that the current claims are patentable over the cited references and rejections. Accordingly, the applicant requests the examiner to allow these claims and an allowance is respectfully solicited.

Respectfully submitted
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